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TREATMENT
of
ORNAMENTAL WHITE PINES
infected with
BLISTER RUST

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THE WHITE-PINE BLISTER RUST kills young pine trees and seriously damages old trees, ultimately causing their death. It was brought from Europe to America on nursery stock within the last 20 years. The disease is widely distributed in the New England States, New York, Wisconsin, and Minnesota.

The blister rust can be controlled and the trees protected from new infections by the eradication of currant and gooseberry bushes within 200 to 300 yards of the pines. These bushes harbor the disease and are the only means of spreading it to the pine trees.

Infected ornamental pines can be saved by properly cutting out the diseased parts, if the work is done in time. The best results will be obtained in the spring, and success depends upon finding and completely removing the cankers. Tree surgery of this kind can be performed by the owner at small cost.

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TREATMENT OF ORNAMENTAL WHITE PINES INFECTED WITH BLISTER RUST.

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THE WHITE PINE AS AN ORNAMENTAL TREE.

THE white pine (*Pinus strobus* L.) is one of America's most beautiful and useful evergreens. Thousands of these trees are growing in parks, on estates, and around homes. In the Northeastern and

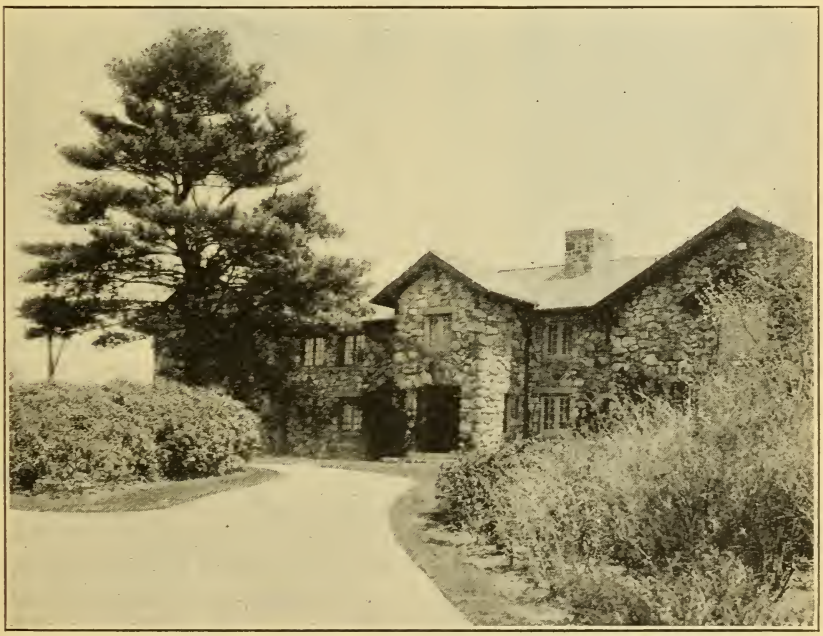

FIG. 1.—An ornamental white-pine tree, the loss of which would greatly mar the beauty of the home.

Lake States the white pine makes an admirable windbreak for the protection of orchards and crops. It is well suited for planting as a single ornamental tree (fig. 1) or in groves or groups and can be used to advantage in mixtures with deciduous trees where contrasts are desired.

WHITE-PINE BLISTER RUST.

HISTORY.

The white-pine blister rust is a serious disease of 5-needled pines. It is native to the Old World, but did not attract much attention in Europe until it was found attacking the white pine. This tree had been introduced in Europe from eastern North America and extensively planted as a forest and ornamental tree under the name of the Weymouth pine. In European countries its culture has been practically abandoned, because of the destructiveness of the blister rust.

About 20 years ago a white-pine reforestation movement was begun in eastern North America. At that time white-pine seedlings

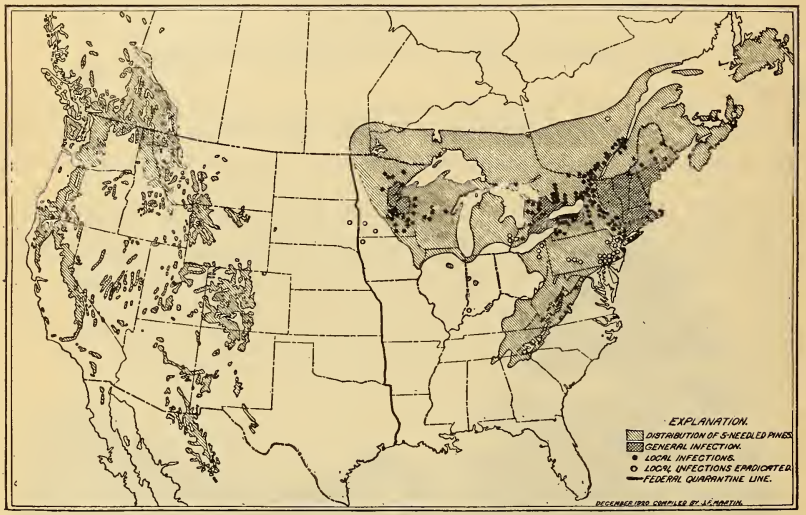

FIG. 2.—Outline map of the United States and the adjoining portions of Canada and Mexico, showing the distribution of the 5-needled pines of North America and the white-pine blister rust. This disease is not present west of the Federal quarantine line. The shipment of 5-needled pines and currant and gooseberry plants into the Western States from points east of the quarantine line is prohibited.

could be grown in European countries and sold to the American trade cheaper than they could be obtained from nurserymen in this country. Millions of these trees were imported and were planted in various places in the eastern part of the United States and Canada. Many of the imported trees were diseased with blister rust, which quickly escaped to our native white-pine forests, where it found exceptionally favorable conditions for spreading. When the danger was recognized, the Federal Government prohibited the further importation of 5-needled pines, but the disease had already escaped in many places. The blister rust is now established in the New England States, New York, Minnesota, and Wisconsin, and in time undoubtedly will spread to other Eastern States, where the white pine is a valuable forest and ornamental tree (fig. 2).

LIFE CYCLE.

The blister rust (*Cronartium ribicola* Fischer) is one of a group of microscopic plants known as rusts which live on other plants. Like many similar fungi, the blister rust requires two different host plants to complete its life cycle. These are the 5-needled pines and the plants of the family Grossulariaceæ, which includes all kinds of currants and gooseberries. The disease can not spread directly from pine to pine. It first lives on the pine, then spreads to currant or gooseberry leaves, where it passes part of its life, and from these returns to the pine, forming cankers on the branches and trunks.

In the spring, sacs of orange-yellow spores push through the diseased bark of white pines (fig. 3). These sacs or blisters break open, and the wind scatters the powdery spores over wide areas. Some of them falling upon the leaves of currant and gooseberry bushes germinate and infect the leaf tissue. After two or three weeks of growth, small orange-yellow pustules appear on the under side of the leaf. These break open, liberating a different kind of spore, which infects other currant and gooseberry leaves in the vicinity. With favorable weather conditions, this reinfection of currant and gooseberry leaves is repeated every two or three weeks during the summer months and greatly increases the amount of local infection. The orange-yellow pustule stage on the under surface of currant and gooseberry leaves is soon followed by numerous brownish, hairlike columns (fig. 4). The

FIG. 3.—A young blister-rust canker with four blisters pushing through the bark at the upper end. The dark irregular-shaped spots around the edge are pycnial scars. (Photographed by R. H. Colley.)

columns are about one-eighth of an inch long and produce the spores which infect pine trees. These spores are also scattered by the wind, falling upon white-pine needles, where they germinate and grow downward through the leaf into the bark. After a period of growth varying from two to four years in the pine bark, new blisters are produced and give off spores that again start the disease upon currant and gooseberry leaves.

After the blisters are once formed on an infected pine, new ones are usually produced annually until the tree is killed.

FIG. 4.—Blister-rust infection on the under surface of a black-currant leaf, producing the spores which infect pine trees. (Photographed by R. Kent Beattie.)

IMPORTANCE.

When the blister rust becomes established in areas where wild or cultivated currant and gooseberry bushes are abundant, the white pines suffer serious damage. The disease quickly kills small trees and seriously injures large ones, eventually causing their death. Merchantable pine trees in forest areas die slowly and can be utilized for timber before the rust has time to kill them. Large ornamental pines, however, soon become unsightly from the loss of many limbs,

and their æsthetic value is greatly reduced a number of years before the trees are killed.

The greatest damage in this country has occurred in young native white-pine growth and young forest and ornamental plantings up to 30 years of age. In several local areas many pines have already been killed or severely damaged, and healthy trees are rapidly becoming infected. Pine infections become more numerous from year to year, and currant and gooseberry leaves more heavily diseased, resulting in severe attacks on pine trees. If allowed to progress unchecked, the blister rust would ultimately destroy the white pine as a commercial tree in regions where wild and cultivated currant and gooseberry bushes are abundant.

The shipment of diseased nursery stock has been the chief means of starting the blister rust in widely separated localities, and this is still a source of great danger. State and Federal quarantine laws have been enacted to prevent the disease from reaching the 5-needled pines of the Rocky Mountain and Pacific Coast States. The cooperation of the public with State and Federal authorities charged with the enforcement of the quarantine laws will do much toward preventing the disease from reaching distant uninfected regions.

The forest value of the 5-needled pines in the United States and Canada is conservatively estimated at more than $1,100,000,000. The annual cut is valued at more than $80,000,000, and in the United States the white pine ranks third in lumber production. These figures do not take into consideration the value of young native reproduction, or ornamental trees that beautify many homes and parks, or the value of white-pine forests in protecting watersheds. Unless controlled, the blister rust will mar the beauty of many landscapes and remove one of our most valuable crops from thousands of acres of rough land unsuited for agricultural purposes.

EFFECTIVENESS OF TREATING INFECTIONS.

White pines heavily infected with blister rust can be saved if treatment is given in time. This has been demonstrated by the results of experimental and practical work. In July, 1917, an experiment in removing infections was begun on a group of 19 ornamental pines at Kittery Point, Me., when 95 infections were cut out at distances ranging from one-fourth of an inch to 6 inches back of the edge of the cankers. Cankers on twigs and branches were removed by cutting off the branches. Infections on trunks and large limbs were treated by removing all diseased bark and a strip of healthy bark around the edge of the cankers. Upon examination in 1920 it was found that all cuts made 1¼ inches or more back of the edge of the canker were healthy.

When blisters were appearing in the spring of 1916, the white pines on an area of severe infection near Ipswich, Mass., were treated by cutting off the diseased parts. The trees were protected from further infection by the eradication of all wild and cultivated currant and gooseberry bushes on the area. Of these ornamental pines, 45, averaging about 20 feet in height, were carefully examined in 1919, and out of a total of 1,086 scars where infected parts had been removed, 998, or 92 per cent, showed no further development of the disease. As a result of this practical work many of the trees which had numerous twig and branch infections in 1916 were apparently healthy three years after treatment. It was evident that the failure to remove the disease completely in most of the unsuccessful cases was caused by making the cut too close to the canker. Reinspection showed that only 69 cankers were missed in 1916, at which time most of these had not developed sufficiently to be easily recognized.

TREES WORTH TREATING.

The question will often arise whether a particular heavily infected pine is worth treating. This must be answered by the owner, as it depends on how highly the tree is valued. The cost of treatment will be very much less than the expense involved in replacing the tree. The practicability of saving a pine must be governed by the extent of the injury already caused. If the disease has nearly girdled the main stem near the ground, time and money spent in trying to save the tree are wasted. It is also unwise to spend money on a tree which has so many limbs infected that it will be left weak or unsightly after the diseased parts are removed.

Where new pine infections are annually occurring in abundance it will be necessary to cut them out each year to prevent the disease from reaching the trunk and killing the tree. The yearly repetition of this operation will be expensive to the owner, and his pines will soon become so badly mutilated that their ornamental value will be destroyed. Therefore, if currant and gooseberry bushes in the immediate vicinity can not be destroyed in order to eliminate the source of new infections, the loss of the ornamental white pines should be anticipated by planting trees of other species to take their place.

SYMPTOMS OF THE DISEASE ON PINE.

Successful surgical work with blister rust depends primarily on thoroughness in finding and removing infections. In order to recognize infections, a practical knowledge of the symptoms of the disease in its different stages is necessary. This can be obtained by studying descriptions, illustrations, and specimens of the disease. Field experience in examining cankers on infected trees is most helpful. Pine injuries resulting from other causes are common and are often

mistaken for blister rust by workmen unfamiliar with the varied appearance of cankers produced by this disease.

YOUNG CANKERS.

About a year after pine twigs become infected they show a more or less spindle-shaped swelling of the bark. The canker, or swollen area, is usually outlined by a greenish yellow margin, which is often tinged with orange. Inside of this margin the diseased bark is a green of a lighter shade than the normal olive green of the healthy bark.

As the canker approaches maturity, small drops of a sweet-tasting fluid appear on the discolored bark during the summer and fall. These drops dry out, leaving small yellowish spots of variable shape that soon become dark reddish brown in color and are called pycnial scars. (See fig. 3.) From April to June many orange-yellow blisters about the size of a navy bean break through the bark of mature cankers. These blisters, or sacs, are full of orange-yellow spores. When they burst open, the spores are scattered by the wind, leaving small ragged holes or spore pits in the bark. White particles of the torn sacs remain around the edge of the ragged holes for some time.

FIG. 5.—Typical canker showing blisters and dead irregularly cracked bark where blisters were formed in previous years.

After the blisters are formed, the bark becomes irregularly cracked (fig. 5), and all parts of the branch beyond the canker gradually die.

The green needles fade to a straw color, and then to deep brown, finally dropping. The dead and dying branches, or "flags," as they are frequently called, show plainly in contrast with the green foliage and are very helpful in locating the disease. Branches killed by shade or other causes do not have the typical irregularly cracked bark caused by blister-rust infection.

OLD CANKERS.

With the death of the branch beyond the canker, the disease continues its downward growth in the live bark at the rate of 2 to 5 inches a year. It works back from the twigs into the larger limbs and trunk, which it eventually girdles, killing the tree. As the disease progresses down the branch or stem, the infected bark shows several distinct zones. Just inside the advancing margin of the disease is a zone of greenish or orange-yellow discolored bark of

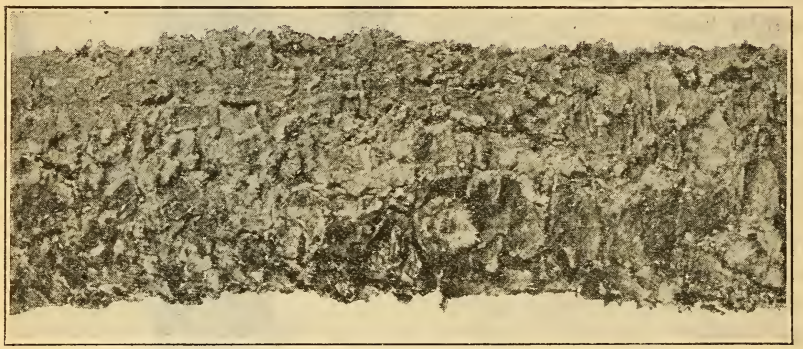

FIG. 6.—An old blister-rust canker with typical rough irregularly cracked bark.

varying width. The older portion usually shows the small dark reddish brown pycnial scars. Next comes the current season's "fruiting" zone, which becomes a mass of orange-yellow blisters between April and June. The fruiting area of previous seasons forms the next zone. It has roughened, irregularly cracked bark, with shallow, ragged spore pits where blisters were formerly produced (fig. 6). Old cankers are frequently more or less covered by pitch, which makes them especially noticeable. Insects often bore into the bark and wood of cankers, producing little piles of pitch and borings on their surface. Conspicuous white areas of barkless wood on infected pines indicate the work of squirrels and other rodents which have eaten off the diseased bark. In a plat of ornamental pines at Kittery Point, Me., the bark on approximately one-fifth of the cankers had been partially eaten, but in every case enough of the diseased bark remained, so that the progress of the rust was not stopped.

VARIATIONS IN THE APPEARANCE OF THE CANKERS.

Blister-rust cankers vary considerably in appearance. This is largely caused by other bark-killing fungi which grow in the diseased bark. These secondary fungi usually cause constricted blister-rust cankers with smooth, partially dead bark and often follow the rust so closely that the formation of blisters is prevented (fig. 7). It is therefore necessary to examine suspicious cases for the discolored margin of the canker and the pycnial scars if no blisters are present.

FIG. 7.—A constricted canker caused by primary blister-rust infection, closely followed by a secondary bark fungus which prevented the formation of blisters.

TREATMENT OF INFECTED TREES.[1]

Under forest conditions the removal of cankers from infected white pines is seldom practicable, because of the relatively small value of the individual tree; but recent experiments indicate that such treatment may be practicable in commercial stands up to 20 years of age, where the removal of infections will increase the value of the tree by allowing it to reach maturity. Pruning and thinning will probably be valuable aids in removing infections from diseased stands of young trees. The cutting out of infections of ornamental pine is easy, and the cost is low in comparison with other types of tree surgery. Cankers can be satisfactorily removed at any time during the year, but the inexperienced man will obtain the best results during May and June, when the abundant orange-yellow blisters make the mature canker plainly visible.

Haphazard cutting on pine trees is certain to give poor results. Only careful, thorough workmen should be allowed to cut out infections, and to obtain good results they must become familiar with the disease before begin-

[1] For details of general tree-surgery work, see Farmers' Bulletin 1178, entitled "Tree Surgery," which will be sent free on application to the Division of Publications, United States Department of Agriculture.

ning work on the trees. In spite of instructions to the contrary, workmen have a tendency to cut off a diseased branch too near the canker, especially when the infection is near the point where the branch joins another or when the removal of the branch would detract from the beauty of the tree. Owners of ornamental white pines ought to become familiar with the disease and examine their treated trees to see that the surgical work has been done carefully and thoroughly.

CANKERS ON SMALL BRANCHES.

Infected branches should be cut off 7 or more inches back of the orange-yellow blisters. If the blisters are not present, find the discolored edge of the canker and cut off the branch 5 or more inches back of this discoloration. In practical work diseased branches should always be cut off flush at the point where they join healthy ones (fig. 8), as such wounds are much less subject to attack by other fungi and insects, and stubs which are left by lopping off branches between the whorls will usually die and be unsightly.

CANKERS ON LARGE LIMBS.

Infections which occur on large limbs are frequently difficult to remove without greatly damaging the limb or spoiling the beauty and symmetry of the tree. The treatment in such cases must be governed by the location of the canker, the extent to which it has encircled the limb, and the value of the limb to the tree.

Cankers near the ends of large limbs are hard to reach, making careful surgical work difficult. Such infections should be treated by cutting off the diseased branches 5 or more inches back of the discolored edge of the canker and flush with a healthy whorl of branches. (See fig. 8.) The same treatment applies to cankers which have nearly encircled the limb, even though the loss of the limb may detract from the symmetry of the tree.

Large-limb cankers located closer to the trunk are more easily reached. The results of experimental work indicate that they can be successfully treated by cutting out all of the diseased bark and a strip of the apparently healthy bark $1\frac{1}{2}$ inches or more wide around the entire margin of the canker. Cutting out a strip of the apparently healthy bark will provide a safety zone and insure the removal of any diseased bark that may extend beyond the discolored edges of the canker. (Fig. 9.) A blister-rust canker grows about twice as fast at the upper and lower ends as along the sides, and better results will be obtained if the safety zone at the ends is increased accordingly. Excellent success follows the treatment of cankers when an allowance for safety is made of $1\frac{1}{2}$ to 2 inches wide along the sides and 3 to 4 inches at each end. Since there is always

a degree of uncertainty in determining the margin of cankers, a greater distance should be allowed when the circumference of the infected part will permit it. On the other hand, when there is not

FIG. 8.—Branch infection on a 12-year-old pine tree. *A* and *B* indicate the edges of the canker; *C*, the point where the branch should be cut off to prevent the disease reaching the trunk. (Photographed by the New York Conservation Commission.)

enough healthy bark to permit a wide safety zone, a narrow one may often be used with success if the work is carefully performed. The certainty of removing all of the disease becomes less as the width of the safety zone is lessened, and therefore treated cankers should

be kept under observation for at least two seasons, to make sure that no further development takes place.

Before beginning to cut out the diseased bark, scrub the outer margin of the canker with a wet cloth or brush, to remove all surface

FIG. 9.—Blister-rust infection of white pine. *C*, Infected limb on an 18-year-old tree, showing how the disease has worked back into the trunk from the original point of infection at *D*. The dotted line *B* indicates the edge of the canker on the trunk. The infected limb with all diseased and healthy bark inside of the solid line *A* must be removed to save the tree. (Photographed by the New York Conservation Commission.)

dirt and bring out more plainly the discolored margin. Locate and mark the edge of the canker. With a sharp hook-pointed knife, cut through the bark to the wood around the entire canker at a suitable distance beyond its outer edge. Then peel off all the bark within the area outlined by the cut, taking care to remove all the inner bark.

The edge of the wound should then be trimmed with a sharp knife, smoothing off all bruised or torn places on the cut surface. All wounds made by this method of treatment, whether on limbs or the main stem, should be V-shaped at both ends. This will assist the wound in healing and prevent the bark from dying back at these points. (Fig. 10.) In spring and summer the bark peels off easily, but at other times when the flow of sap is decreased the work is more difficult.

It is seldom advisable to try to save limbs by this means when the bark must be removed from more than two-thirds of the circumference of the limb. Removing a large percentage of the bark about the circumference of a limb at any point will cause the exposed wood to dry out partially, making it somewhat brittle and more likely to be broken by wind and snow. Until the wound has healed sufficiently to permit the normal passage of food materials, the limb beyond

FIG. 10.—A blister-rust canker successfully treated in 1917 by removing the diseased bark. In November, 1920, the limb was healthy and the healed edges were steadily closing over the scar.

the wound will be more or less weakened. Under such conditions, secondary insects and fungi may attack the limb and cause its death. When it is apparent that the limb has little chance to recover if treated, it is better practice to cut it off flush with the next larger limb or trunk.

CANKERS ON THE TRUNK.

The main stem is the most important part of the tree to be considered. When the disease reaches the trunk, the resulting canker encircles the stem and finally causes the death of the tree. Cankers which have not girdled the trunk are treated in the manner described for similar cankers on large limbs. (See fig. 9.) In general, when it is necessary to remove more than two-thirds of the bark about the circumference of the stem at any point, saving the tree is doubtful except when the canker is near the upper end of the stem and the removal of the top of the tree will not entirely spoil its appearance. The advisability of treating or cutting down such trees will depend upon their size, ornamental value, and the distance of the canker

from the ground. The removal of the bark checks the annual growth on the exposed wood until the wound is healed. The continued growth of the tree above the injury may make it top-heavy, causing the tree to break off at the point weakened by the wound.

TOOLS.

The tools needed for the removal of blister-rust infections are few and inexpensive. With a sharp knife or pruning shears infected branches on small trees can be easily and quickly removed. On large trees most of the infections are near the ends of branches where they are difficult to find and remove. Ladders and long-handled pruning clippers can be used to advantage on these trees. When using long-handled clippers, the workmen must be careful to cut far enough back from the canker, as the greater distance makes it much easier to misjudge the necessary safety zone.

A wide-toothed pruning saw is the best tool for removing large branches and limbs. If only a little work is necessary, other common types of crosscut saws will serve nearly as well. When removing limbs precautions should be taken to prevent the bark stripping off below the cut. This can be avoided by severing the limb from 6 inches to a foot beyond the point where the final cut will be made. First, saw a little on the under side of the limb and then saw through from above. Saw off the remaining stub flush with the joining limb or trunk, and smooth the edges of the wound with a sharp knife. A sharp hook-pointed knife gives good results in peeling off diseased bark. Always wear soft-soled shoes when climbing through the trees, to prevent bruising and injuring the bark.

PAINTING WOUNDS.

After the diseased bark has been removed, it is important to protect the wound. Ordinarily, when cuts are made in pine bark the copious exudation of resin seals the exposed bark cells. The exuding resin is sometimes smeared over the exposed wood of large cuts to afford protection from drying out and to ward off attacks of fungi and insects. There is usually such an abundant flow of resin that it runs down the branch or stem, leaving chalklike streaks of unsightly appearance. This can be lessened by sealing the wound with shellac and after it is dry applying a coat of tar or a thick bark-colored paint. This treatment will make the cut surfaces much less noticeable, and it is good practice to repaint them when the first coat begins to crack or peel. It is not necessary to protect small wounds near the ends of branches.

NEED OF ANNUAL INSPECTIONS.

It is practically impossible to find all of the infections on a medium or large sized tree at one inspection. Some of the young cankers

will be overlooked and others not developed sufficiently to be found, because of the time required for cankers to mature after pine infection takes place. The few which are missed will continue to develop and they can be found more easily the following year. Valuable trees should be inspected annually until no further infections can be found. The wounds of cankers previously treated should be examined at the same time to make certain that they were successfully removed. Occasionally infections from long distances or from escaped currant or gooseberry bushes in the vicinity make additional inspections advisable from time to time.

PROTECTING TREES FROM NEW INFECTIONS.

CONTROL OF BLISTER RUST.

Wild and cultivated currant and gooseberry bushes must be destroyed in regions where blister rust is present, to protect white pines from this disease. Scientific experiments and practical experience prove that under average conditions the removal of currant and gooseberry bushes within a distance of 900 feet of white-pine trees will afford adequate protection for forest growth. Under favorable conditions 600 feet is sufficient, but, on the other hand, experience has shown that large patches of cultivated black currants may cause serious damage if located within a mile of white pines. Even in the absence of black currants occasional infections may occur at greater distances than 900 feet. Such infections are of no practical importance in the forest, as the death of a few scattered trees amounts to no more than natural thinning, but on a valuable ornamental pine one neglected infection may kill the tree.

In 1916 about 80 per cent of the currants and gooseberries were removed on an area of severe pine infection which contained many native and ornamental pine trees. An intensive inspection of 17,811 of these pines in 1920 showed that a total of 653 infections took place during the 8-year period from 1912 to 1919, inclusive. Of these, 565 occurred during the 4-year period from 1912 to 1915, and 88 during the 4-year period from 1916 to 1919. This shows that the eradication of not more than four-fifths of the currant and gooseberry bushes in 1916 caused a reduction of 86.6 per cent in the rate of pine infection and that this method of control is practicable and effective. Under trained supervision unskilled laborers can be quickly taught to find and destroy at least 95 per cent of the wild currants and gooseberries in going over the ground once. (Fig. 11.) The bushes reproduce slowly, and those missed are usually small plants well screened by underbrush and with very little leaf-infecting surface. Recent investigations indicate that in some types of growth it will probably be necessary to rework the ground in from 8 to 15 years, while in others the first working will be sufficient to give the pines permanent protection. The cost is low, averaging only 24 cents per

acre for the New England States in 1920, and it is expected that this expenditure will be reduced as improved methods are developed.

Adequate protection can best be assured by concerted community action or by groups of neighbors getting together and destroying all

FIG. 11.—Crew eradicating wild currant and gooseberry bushes to protect near-by white-pine stands from further damage by blister rust.

BENEFITS OF COOPERATION.

wild and cultivated currant and gooseberry bushes on their properties. In this way the bushes will be destroyed on a large area, and the pines will be better protected from occasional long-distance infections. The United States Department of Agriculture is cooperating with a number of States in the control of this disease. Towns, associations, or individual pine owners can benefit in this cooperation and receive assistance in protecting their pines from the blister rust. In many localities the currants and gooseberries have been removed, and control work is steadily progressing in many parts of the New England States, New York, Wisconsin, and Minnesota.

NECESSITY FOR IMMEDIATE ACTION.

The blister rust is an insidious disease. It may be present in a locality for a number of years before infection on pine trees becomes evident to the casual observer. Owners of valuable ornamental pines will usually fail to notice any signs of the disease until some of the small trees and the large branches of old trees are killed. Often when this happens the pines have become infected so heavily that they can not be saved without destroying their ornamental value.

The disease has been present in most of the infected localities for comparatively few years, so that immediate action will result in saving nearly all of the ornamental pines. In many local areas the native pines are rapidly becoming infected. This is emphasized by recent surveys in New York, Vermont, Massachusetts, and New Hampshire, where the inspection of native pines on 99 miles of rod-wide strip lines showed approximately 10 per cent of the trees already diseased. Do not wait until your pines begin to die (fig. 12), but protect them immediately. Delay means ultimate loss.

SUMMARY.

White pine is a valuable ornamental and forest tree that is seriously threatened by the blister rust, a destructive disease of 5-needled pines. This rust was imported from Europe within the past 20 years and has now become widely established in the New England States, New York, Wisconsin, and Minnesota. The disease can not spread from tree to tree. It must first pass through a transitional stage on currant or gooseberry leaves before it can infect pine trees. It attacks pines of all ages, quickly killing young trees and seriously damaging old ones, ultimately causing their death. The effect of the blister rust, especially on large trees, is not very apparent until several years after infection takes place, so that pines may become severely infected before the disease is noticed. At the present time native pines are rapidly becoming diseased in the generally infected regions of New England and New York.

Experimental and practical results show that ornamental pines which have already become diseased can be saved by cutting out the infected parts if treatment is applied in time. The work is easily performed at a comparatively low cost. Treatment can be given any time during the year, but the best results will be obtained from April to June when the cankers are more easily found because of the bright orange-yellow blisters. Successful treatment depends primarily upon the ability to find the cankers and determine accurately the edge of the diseased area. The workmen should be thoroughly familiar with the symptoms and appearance of the disease on pines.

Diseased twigs and branches should be cut off 7 or more inches back of the orange-yellow blisters. If no blisters are present they should be cut off 5 or more inches back of the extreme edge of the canker and flush with the next whorl of healthy branches. Infections on large limbs and trunks can be successfully treated by re-

moving all the diseased bark and a strip at least 2 inches wide at the sides and 4 inches at the ends of the apparently healthy bark from around the edge of the canker. Large wounds should be protected from the attacks of other fungi and insects by a covering of shellac and bark-colored paint. Valuable trees should be inspected annually for a few years, limb by limb, and additional inspections are advisable thereafter from time to time.

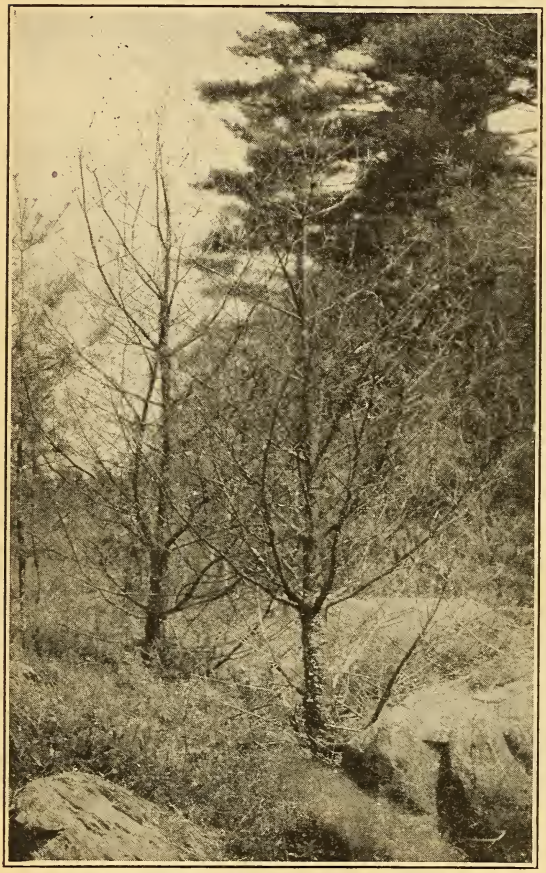

FIG. 12.—White-pine trees killed by the blister rust. To prevent the death of such trees, destroy all wild and cultivated currant and gooseberry bushes in the vicinity and cut out any cankers that have developed on ornamental trees.

Treatment of infected trees is of little value unless they are first protected from new infections. Five-needled pines can be adequately protected under average conditions by uprooting all wild and cultivated currant and gooseberry bushes within 600 to 900 feet of the trees. In the control of this disease the United States Department of Agriculture is cooperating with the States in which it is present. Towns, associations, and individual pine owners can join in this cooperation and receive assistance in protecting their trees from the blister rust. Owners should act immediately to save their trees from serious infection, as protection is thoroughly practicable and the cost low.

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